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New records of *Puccinia* and *Pucciniastrum* from Pakistan

N. S. Afshan & A. N. Khalid

pakrust@gmail.com
Department of Botany, University of the Punjab
Quaid-e-Azam Campus, Lahore, 54590, Pakistan

Abstract — Six species of rust fungi from northwestern Pakistan are described. Among these, *Puccinia bolleyana, P. pygmaea* var. *pygmaea,* and *Pucciniastrum areolatum* are new records for Pakistan.

Key words — North-West Frontier Province, *Pucciniales, Pyrus pashia*

Introduction

During rust surveys in Pakistan, six species of rust fungi were found and collected on different host plants in the northwestern region. Among these, three rust taxa — *Puccinia bolleyana* on *Carex flacca*, *P. pygmaea* var. *pygmaea* on *Agrostis gigantea* and *Pucciniastrum areolatum* on *Pyrus pashia* — are new additions to the rust flora of Pakistan. *Leersia oryzoides* is a new host for *Puccinia striiformis* var. *striiformis* in Pakistan. *Puccinia cynodontis* and *Puccinia pilearum* have previously been reported from Pakistan, but here they are reported from the North-West Frontier Province for the first time and their descriptions are updated.

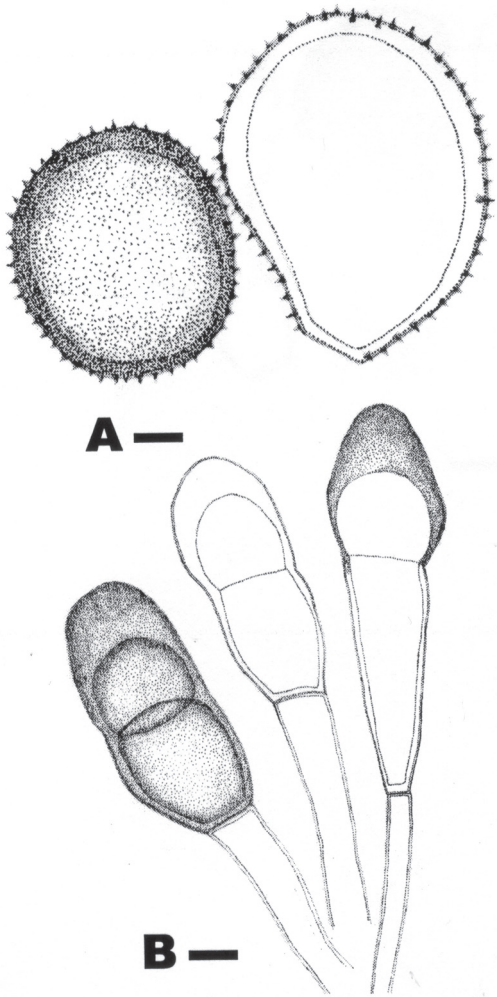
Materials and methods

Specimens were collected from different areas of Pakistan. Freehand sections of infected tissues and spores were mounted in lactophenol and gently heated to boiling. The preparations were observed under a NIKON YS 100 microscope and photographed with a digipro-Labomed and a Scanning Electron Microscope. Drawings were made using a Camera Lucida (Ernst Leitz Wetzlar, Germany). Spore dimensions were taken with an ocular micrometer. At least 25 spores were measured for each spore stage. The rusted specimens have been deposited in the Herbarium of Botany Department, University of the Punjab, Lahore (LAH).

Enumeration of taxa

Puccinia bolleyana Sacc., Syll. fung. (Abellini) 9: 303 (1891) (Figs. A–B)

Spermogonia and aecia unknown. Uredinia mostly hypophyllous, sometimes amphigenous, on leaves and culms, intermixed with telia. Urediniospores ovoid to ellipsoid, (15–)18–24 × 23–32 µm (mean 20.4 × 26.5 µm); wall 2–3 µm thick, pale brown to cinnamon brown, finely echinulate; germ pores 2,



Figs. A–B. Drawings of *Puccinia bolleyana*.
A. Mature urediniospores showing germ pores (scale bar = 6 µm).
B. Mature teliospores (scale bar = 12 µm).

equatorial, pedicel hyaline, 5–7 × 20–25 µm. Telia mostly hypophyllous, rarely amphigenous, intermixed with uredinia, dark brown to blackish brown, covered by the epidermis, 0.2–0.4 × 0.2–0.5 mm. Teliospores clavate to oblong, constricted at the septum, rounded above, narrowed below, 21–24 × (28–)40–59 µm (mean 22.74 × 47.53 µm); wall 2–3 µm thick, chestnut brown to golden brown, smooth; apex mostly rounded, 6–10 µm thick; germ pores obscure; pedicel persistent, cylindrical, hyaline to light brown, thin walled, 7–10 µm wide and up to 70 µm long.

Material examined: On *Carex flacca* Schreb., Pakistan, North-West Frontier Province (NWFP), Khanspur, at 2575 m a. s. l., 16^{t} September 2007, NSA # 16096 [II, III], (LAH Herbarium No. NSA 1033).

The rust fungi already reported on *Carex* spp. from Pakistan include *Puccinia caricina* DC. and *P. caricis-filicinae* Barclay on *Carex filicina* Nees; *P. dioicae* Magnus and *P. pakistani* S. Ahmad on *Carex nubigena* D. Don. ex Tilloch & Taylor (Ahmad et al. 1997). *Puccinia bolleyana* is a new record for Pakistan.

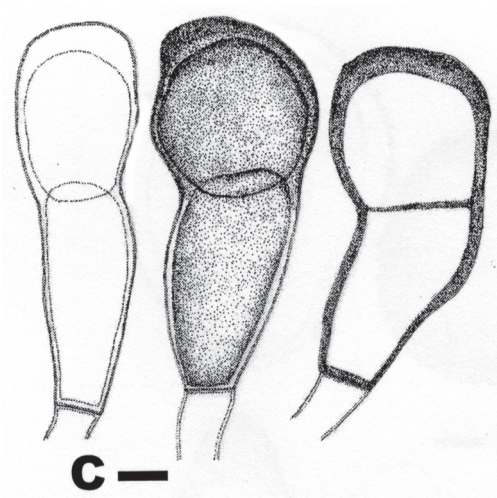


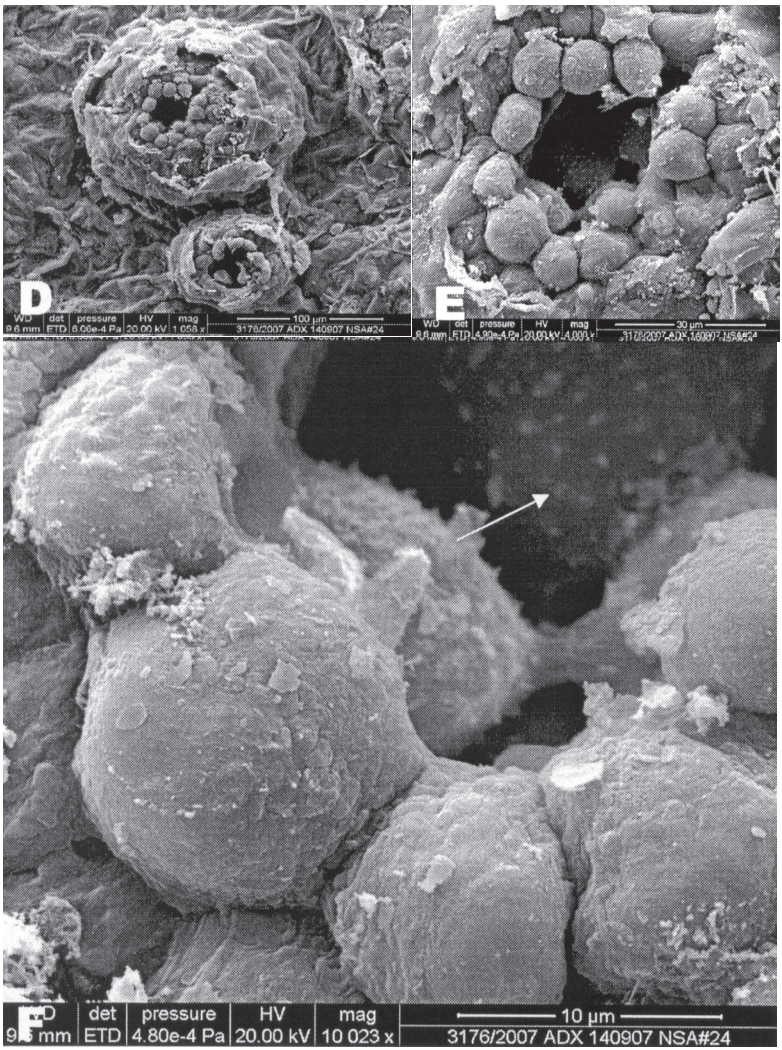
Fig. C. Lucida drawing of teliospores of *Puccinia pygmaea* var. *pygmaea* (scale bar = 9 µm).

Puccinia pygmaea Erikss., Fungi paras. scand: no. 449 (1895) **var. *pygmaea***
(Fig. C)

Spermogonia, aecia and uredinia not found. Telia amphigenous, covered by the epidermis, dark brown to blackish brown, loculate, 0.09–0.5 × 0.2–0.8 mm. Teliospores 1–2-celled by transversal septum, clavate or ellipsoid; wall 1.5–2 µm thick, pale brown to chestnut brown, smooth; 13–20 × 38–56 µm (mean 16.62 × 47.54 µm); apex mostly truncate, sometimes rounded to conical,

3–6 µm thick; germ pore 1 per cell, obscure; pedicel hyaline to light brown, 5–7 × 6–12 µm, one-celled spores rare.

Material examined: On *Agrostis gigantea* Roth, Pakistan, North-West Frontier Province (NWFP), Bara Gali, at 2407 m a. s. l., 12ᵗ October 2007. , NSA # B13 [II], (LAH Herbarium No. NSA 1084).



Figs. D–F. *Pucciniastrum areolatum*. D–E. SEM photographs of subepidermal uredinial sori containing peridial cells and urediniospores F. Urediniospores (shown by arrow) surrounded by peridial cells.

Puccinia pygmaea has been reported on *Agrostis munroana* Aitch. & Hemsl. from Kaghan valley by Ahmad (1956a, b).

Six varieties of *P. pygmaea* have been recognized on the basis of spore sizes, viz. *P. pygmaea* var. *ammophilina* (Mains) Cummins & H.C. Greene, *P. pygmaea* var. *chisosana* Cummins, *P. pygmaea* var. *pygmaea*, *P. pygmaea* var. *minor* Cummins & H.C. Greene, *P. pygmaea* var. *angusta* Cummins & H.C. Greene, and *P. pygmaea* var. *major* Cummins & H.C. Greene (Cummins 1971). *Puccinia pygmaea* var. *pygmaea* is a new record for Pakistan.

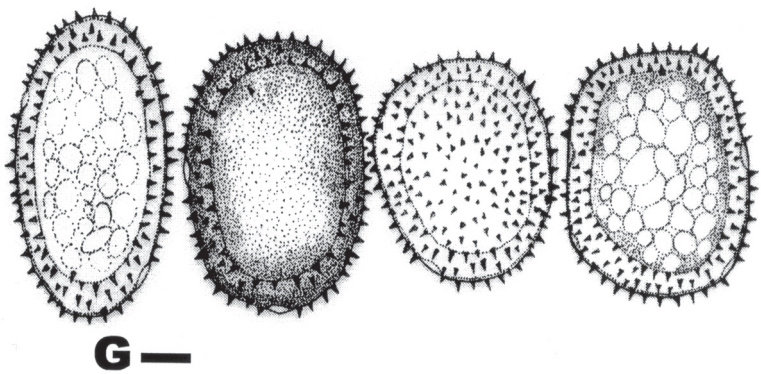


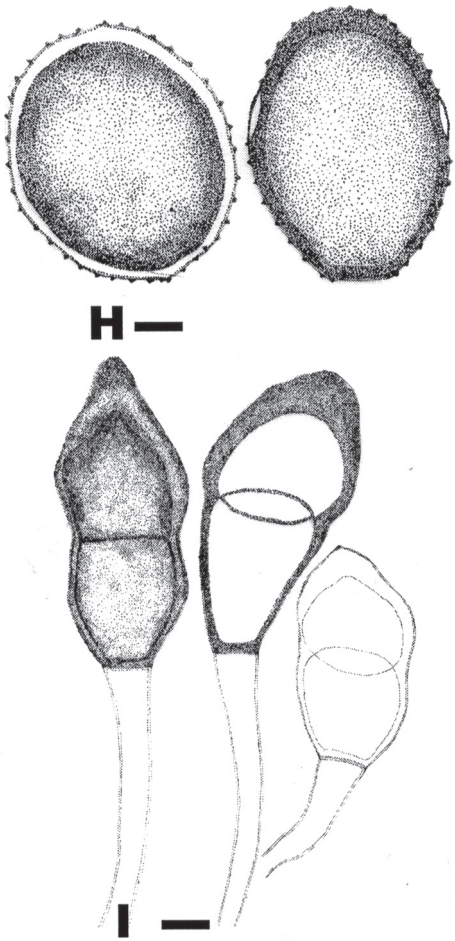
Fig. G. Mature urediniospores of *Pucciniastrum areolatum.* Scale bar = 10 µm.

Pucciniastrum areolatum (Fr.) G.H. Otth, Mitt. naturf. Ges. Bern 1863: 85 (1864) (Figs. D–G)

Spermogonia, aecia and telia not found. Uredinia hypophyllous, 0.07–0.1 × 0.08–0.2 mm, light yellow to light brown, subepidermal, minute, crowded, in small groups, covered by a hemispherical peridium, opening by a pore. Peridial cells minute, cubicle to irregular, thin walled, hyaline to light yellow, smooth, ostiolar cells irregular in shape. Urediniospores sub-globose or ellipsoid to broadly ellipsoid, 14–20 × 15–26 µm; wall 1–1.5 µm thick, hyaline to light yellow, echinulate; germ pores 2–5, scattered, obscure; pedicel deciduous, cylindrical, hyaline, minute, fragile. Paraphyses not seen.

Material examined: On *Pyrus pashia* Buch.-Ham. ex D. Don, Pakistan, Northern Areas, Gilgit, at 2575 m a. s. l., 21^{s} August 2007, NSA # 36 [II], (LAH Herbarium No. NSA 1103).

Pucciniastrum areolatum is a new record for Pakistan. No rust fungus has been previously reported on *Pyrus* from Pakistan.



Figs. H–I. *Puccinia cynodontis.*
H. Finely verrucose urediniospores (scale bar = 10 µm).
I. Mature teliospores (scale bar = 12 µm).

Puccinia cynodontis Lacroix, in Desmazières, Pl. Crypt. France, 2e Éd., 2e Sér.: no. 655 (1859) (Figs. H–I)

Spermogonia and aecia unknown. Uredinia amphigenous, mostly on abaxial surface, subepidermal, yellowish brown to cinnamon brown, 0.09–0.1 × 0.1–2.0 mm. Urediniospores globose to subglobose, 19–27(–30) × (21–)23–33 µm (mean 25.04 × 27.98 µm); wall 2–3 µm thick, pale brown to cinnamon brown, finely verrucose; germ pores 2–3, equatorial, pedicel persistent, cylindrical, hyaline, short. Telia mostly abaxial, sometimes amphigenous, early exposed,

dark brown to blackish brown, 0.2–0.4 × 0.2–0.6 mm. Teliospores two-celled by transverse septum, clavate to ellipsoid, 18–28 × (28–)37–45(–58) µm (mean 23.30 × 43.26 µm); wall 2–3µm thick, chestnut brown to golden brown, smooth; apex mostly acuminate, 6–10 µm thick; germ pores obscure; pedicel persistent, cylindrical, hyaline to light brown, thin walled, 10–12 × 60–70 µm.

Material examined: On *Cynodon dactylon* (L.) Pers., Pakistan, North-West Frontier Province (NWFP), Khanspur, at 2575 m a. s. l., 29^{t} July 2006. NSA # 71 [II, III], (LAH Herbarium No. NSA 1051).

Puccinia cynodontis has been reported on *Cynodon dactylon* from Tandojam, Karachi, Faisalabad and Quetta by Sydow and Ahmad (1939), Ahmad (1956a, b), Hasnain et al. (1959), Khan and Kamal (1968), Ghaffar and Kafi (1968), Malik et al. (1968) and Malik & Virk (1968). It is herein reported for the first time from north-west Pakistan.

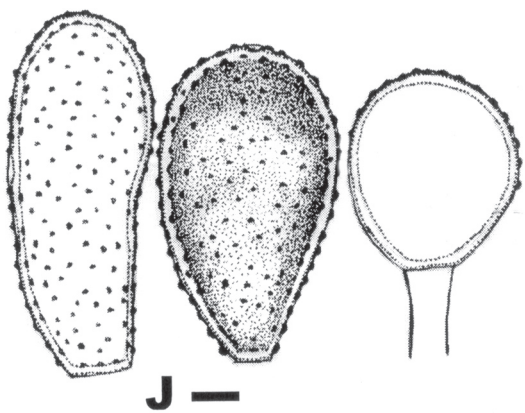


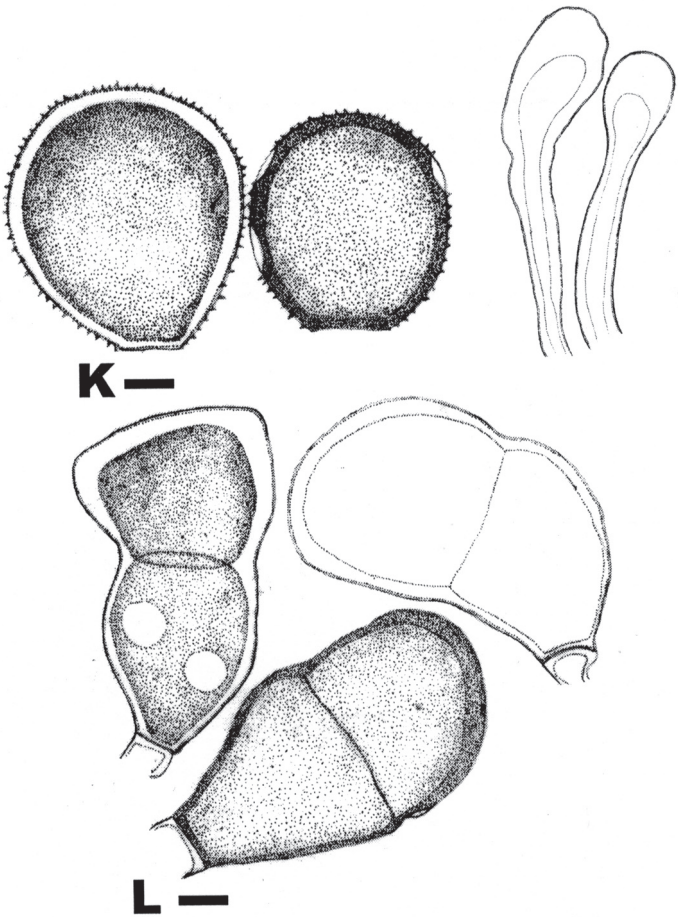
Fig. J. Mature urediniospores of *Puccinia pilearum*. (scale bar = 8 µm).

Puccinia pilearum Durrieu, Mycotaxon 9(2): 488 (1979) (Fig. J)

Spermogonia and aecia unknown. Uredinia epiphyllous, scattered over the whole leaf surface, 0.07–0.1 × 0.1–0.3 mm, pale brown, covered by the epidermis. Urediniospores sub-globose or ellipsoid to broadly ovoid, 13–18 × 17–32 µm; wall 1.4–2 µm thick, hyaline to pale yellow, verrucose; germ pores scattered, very obscure; deciduous, cylindrical pedicel hyaline, short, up to 15 µm long.

Material examined: On *Pilea umbrosa* Wedd., Pakistan, North-West Frontier Province (NWFP), Khanspur, at 2575 m a. s. l., 21^{s} August 2005. NSA # 33 [II], (LAH Herbarium No. NSA 1076).

Puccinia pilearum has been reported on *Pilea umbrosa* from Kaghan valley, Sharan and north of Kawai by Ono (1992) and Ono & Kakishima (1992). It is new record for Khanspur (NWFP).



Figs. K–L: *Puccinia striiformis* var. *striiformis*.
K. Urediniospores and paraphyses. L. Teliospores.
(scale bar for K & L = 10 µm).

Puccinia striiformis Westend., Bull. Acad. Roy. Sci. Belgique 21: 235 (1854)
var. *striiformis* (Figs. K–L)

Spermogonia and aecia unknown. Uredinia mostly on the adaxial surface, sometimes amphigenous, yellow to yellowish orange, 0.05–0.06 × 0.2–0.3 mm. Urediniospores ellipsoid-broadly ellipsoid or broadly obovoid, hyaline to pale yellow, closely echinulate, 16–24 × 23–33 µm; wall 1.5–2 µm thick; germ pores 10–12, scattered, obscure. Pedicel deciduous, short. Paraphyses intermixed, abundant, hyaline, cylindric to capitate, apex 17–20 µm thick, 6–8 µm wide

at the base and up to 90 µm long. Telia amphigenous or mostly abaxial, black, striate, covered by the epidermis, loculate, 0.09–0.15 × 0.03–0.04 mm, surrounded by a few paraphyses. Teliospores 2-celled by transversal septum, but one-celled teliospores are also common, mostly oblong-clavate or variable, 18–26 × 35–58 µm, pale golden to chestnut brown, often paler basally; wall 1.5–2 µm thick at the sides, 3–6 µm thick apically, apex truncate, rounded or conical, not or slightly constricted at septa, base attenuated; pedicel short, 6–8 × 6–17 µm.

Material examined: On *Leersia oryzoides* (L.) Sw., Pakistan, North-West Frontier Province (NWFP), Khanspur-Ayubia, at 2575 m a. s. l., 20th September 2006. NSA # 85 [II, III], (LAH Herbarium No. NSA 1091).

Puccinia striiformis has been reported on *Triticum aestivum* L., *Hordeum vulgare* L. and *Poa* sp. from Quetta, Kalat, Tandojam, Rawalpindi, Nathia Gali (NWFP), Shogran (Kaghan valley), Lahore by Ahmad (1956a, b), Khan & Kamal (1968), Malik et al. (1968), Malik & Virk (1968) and Kakishima et al. (1993b). *Leersia oryzoides* is a new host for this rust species in Pakistan.

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Literature cited

Ahmad S. 1956a. *Uredinales* of West Pakistan. Biologia 2(1): 29–101.

Ahmad S. 1956b. Fungi of Pakistan. Biological Society of Pakistan, Lahore Monograph 1: 1–126.

Ahmad S, Iqbal SH, Khalid AN. 1997. Fungi of Pakistan. Nabiza Printing Press, Karachi, Pakistan.

Cummins GB. 1971. The Rust Fungi of Cereals, Grasses and Bamboos. Springer Verlag, Berlin-Heidelberg-New York.

Ghaffar A, Kafi A. 1968. Fungi of Karachi. Pak. J. Sc. 20: 5–10.

Hasnain SZ, Khan A, Zaidi AJ. 1959. Rusts and smuts of Karachi. Bot. Dept. Karachi Univ. Mont. 2, pp. 36.

Kakishima M, Izumi O, Ono Y. 1993b. Graminicolous rust fungi (*Uredinales*) from Pakistan. Cryptogamic Flora of Pakistan 2: 181–186.

Khan SA, Kamal M. 1968. The fungi of South West Pakistan. Part 1. Pak. J. Sci. & Ind. Res. 11: 61–80.

Malik SA, Virk. 1968. Contribution to the knowledge of parasitic fungi of Quetta-Kalat Region. Biologia 14: 27–35.

Malik SA, Javaid MT, Ahmad M. 1968. *Uredinales* of Quetta-Kalat region of Pakistan. Biologia 14: 37–46.

Ono Y. 1992. *Uredinales* collected in the Kaghan Valley, Pakistan. Cryptogamic Flora of Pakistan 1: 217–240.

Ono Y, Kakishima M. 1992. *Uredinales* collected in the Swat Valley, Pakistan. Cryptogamic Flora of Pakistan 1: 197–216.

Sydow H, Ahmad S. 1939. Fungi Punjabensis. Ann. Mycol. 37: 439–447.